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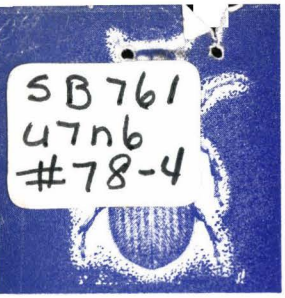

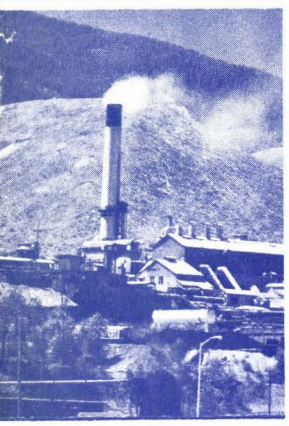

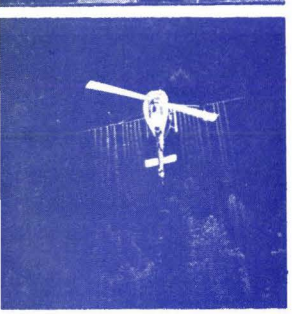

FOREST INSECT & DISEASE MANAGEMENT

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STATUS OF MOUNTAIN PINE BEETLE INFESTATION, BOZEMAN-GALLATIN RANGER DISTRICT, GALLATIN NATIONAL FOREST, 1977

By

M. D. McGregor and D. R. Hamel, Entomologists
and
H. E. Meyer, Biological Technician

ABSTRACT

Mountain pine beetle populations developed to epidmic level on the Bozeman-Gallatin Ranger District in 1969. Approximately 146,000 acres are currently infested. Since 1969, over 350 MMBF have been killed. It is predicted that over 4 million trees could be killed in 1978. Infestation is predicted to intensify in high-hazard stands. Populations have declined in areas where infestation first developed in 1969. Potential losses can be reduced through an accelerated program of (1) sanitation salvage cutting and (2) silvicultural management. High hazard stands should receive first priority.

INTRODUCTION

Mountain pine beetle (Dendroctonus ponderosae Hopk.) populations have been epidemic in lodgepole pine (Pinus contorta var. latifolia Engelm.) stands on the Bozeman-Gallatin Ranger District, Gallatin National Forest, since 1969. Infestation has progressed steadily south up the Gallatin Canyon to Buffalo Horn Creek; throughout the West Fork Gallatin River drainage; southwest of Bozeman to the Bear Trap-Madison River junction; south of Bozeman from Cottonwood Creek east to Timberline Creek; and new infestation was detected north of Bozeman in the Bridger Mountains (figure 1).

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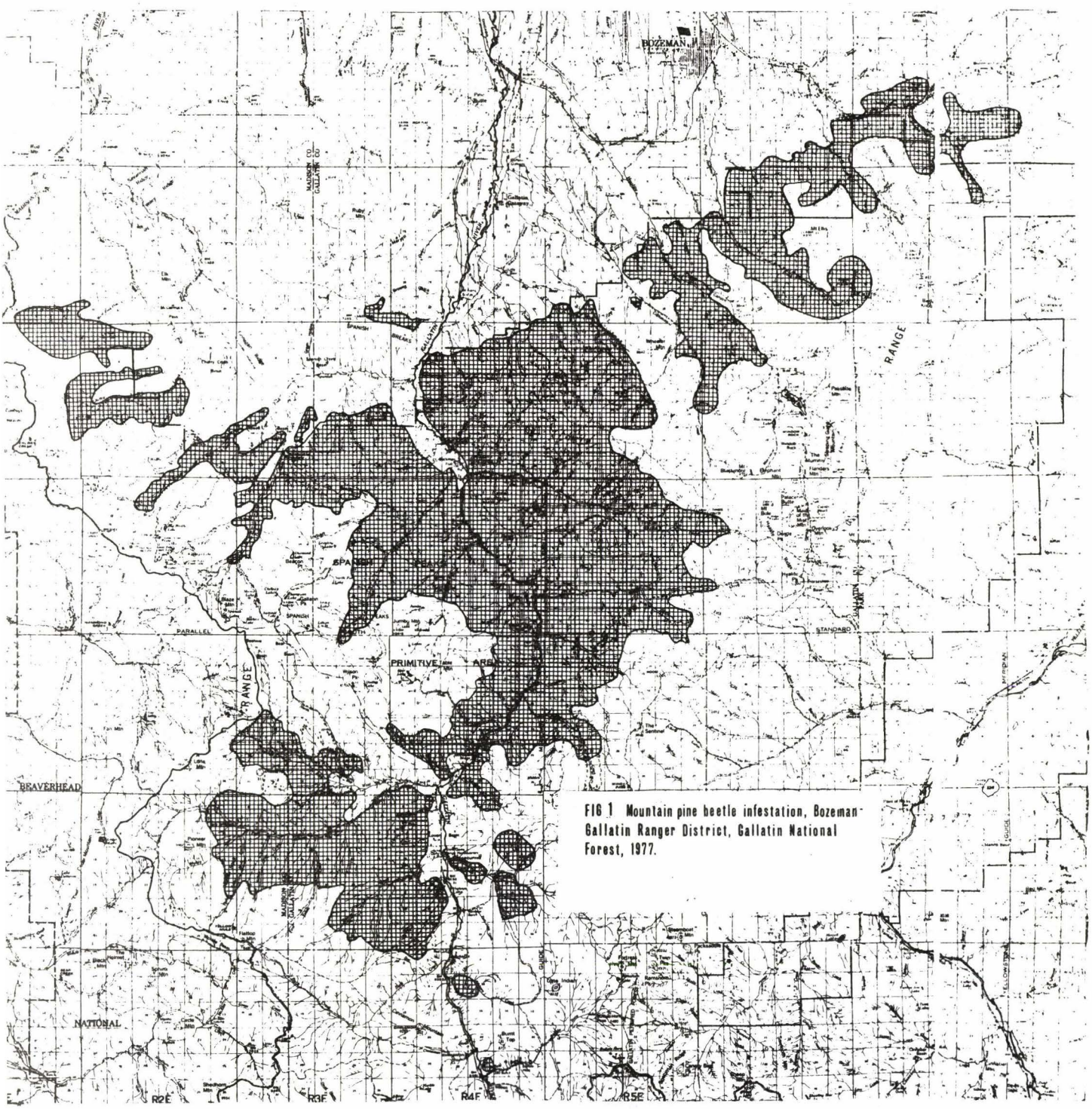

FIG 1 Mountain pine beetle infestation, Bozeman-Gallatin Ranger District, Gallatin National Forest, 1977.

Size of area infested increased from 1,300 acres in 1969 to 146,000 acres by 1977. Buildup ratio of old to newly attacked trees has exceeded 1:1 annually. Tree mortality is continuing at a high level in susceptible stands, with the exception of some areas west of the Gallatin Highway from Castle Rock south to Hellroaring Creek where infestation has run its course and subsided. Since 1969, over 350 MMBF of merchantable timber has been killed.

Because of areas being designated for a specific purpose under multiple-use management, it is not practical or desirable to conduct surveys or do direct control in much of the infested area. Therefore specific units have been designated where management will take place to reduce beetle populations and alter the course of future outbreaks.

Plots were established in specific management units to obtain tree and volume loss estimates and buildup ratios that will be used for predicting infestation trend, and providing information the Forest can use in management planning.

METHODS

Tree and volume loss estimates/acre and buildup ratios were based on ninety 1/10-acre plots located on lines at 5-chain intervals in nine drainages. A hypsometer was used to determine trees to be tallied within plots. All green and infested trees 5 inches d.b.h. (diameter at breast height) and larger were recorded to the nearest millimeter, and placed into one of the following classes:

0 = Healthy trees
1 = Unknown or natural mortality
2 = Current beetle attack
3 = 1-year-old attack
4 = 2-year-old attack
5 = Unsuccessful attack

Heights were recorded on each of two tree species/plot for estimating volume loss. Data were analyzed by the computer program INDIDS (Bousfield 1977). Data were used for predicting additional tree mortality that could occur in 1978.

RESULTS

Infestation intensity.--Infestation intensity by year is presented in table 1. Number of infested trees/acre was 6.7 in 1975 (range 1-15); 10.5 in 1976 (range 2-24); and 30.6 (range 2-133) in 1977. Based on this, approximately 4 million trees are currently infested. Buildup ratios of old to newly attacked trees was 1:1.6 from 1975 to 1976; and 1:2.8 from 1976 to 1977.

Mortality in trees ≥ 12 inches d.b.h. was three times that of trees < 11.9 inches d.b.h. Nineteen percent of the mortality occurred in trees 5 to 11.9 inches d.b.h., and 48 percent in trees ≥ 12 inches d.b.h. In areas surveyed, lodgepole pine mortality increased from 4.7 percent in 1975, to 7.5 percent in 1976, and to 18.5 percent in 1977. Thirteen percent of the stand mortality occurred in stands from 5 to 11.9 inches d.b.h., and 28 percent in stands ≥ 12 inches d.b.h. Stand mortality was 15.3 percent in 1975, 22.4 percent in 1976, and 62.1 percent in 1977.

Volume loss averaged 450 bd. ft./acre in 1975 (range 48 to 1,417 bd. ft./acre); 475 bd. ft./acre in 1976 (48 to 1,156 bd. ft./acre); and 800 bd. ft./acre in 1977 (range 41 to 1,496 bd. ft./acre). During the period 1975 through 1977, 24.6 percent of the volume killed occurred in 1975, 26.0 percent in 1976, and 49.3 percent in 1977.

Table 1.--Summary of mountain pine beetle infested stands surveyed, Bozeman-Gallatin Ranger District, Gallatin National Forest, 1977

Area	D.b.h.	Trees/acre infested			Volume/acre infested (bd. ft.)			Percent lodgepole pine killed			Percent stand killed			Totals	
		1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977	Percent LPP killed	Percent stand killed
Spanish Creek 1	0- 4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	3	2	4	72	48	164	2	2	3	1	1	2	7	6
	≥ 12.0	2	--	7	206	--	991	6	--	21	4	--	17	26	21
	Total	5	2	11	278	48	1155	3	2	8	2	1	6	11	9
Spanish Creek 2	0- 4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	7	8	18	72	206	400	4	5	13	3	4	10	22	21
	≥ 12.0	1	2	3	107	172	338	6	13	21	4	10	17	35	29
	Total	8	10	21	179	378	738	5	6	14	3	5	11	23	18
Squaw Creek	0- 4.9	--	--	30	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	6	18	46	93	144	547	3	10	27	2	5	14	30	20
	≥ 12.0	1	--	--	185	--	--	100	--	--	20	--	--	100	20
	Total	7	18	76	278	144	547	4	10	38	2	5	21	45	26
Swan Creek	0- 4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	1	11	8	48	298	259	2	17	15	1	10	9	31	19
	≥ 12.0	--	1	4	--	98	483	--	11	50	--	4	21	56	24
	Total	1	12	12	48	392	742	2	17	20	1	9	11	34	20
Portal Creek	0- 4.9	--	--	60	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	12	20	72	546	565	1321	6	10	39	4	7	29	48	37
	≥ 12.0	3	4	1	314	591	175	37	80	100	27	50	25	100	73
	Total	15	24	133	878	1156	1496	7	13	54	5	9	43	61	49
Porcupine	0- 4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	--	--	4	--	--	102	--	--	15	--	--	4	15	4
	≥ 12.0	1	--	4	298	--	401	6	--	27	3	--	10	31	13
	Total	1	--	8	298	--	503	2	--	20	1	--	5	21	6
Bear Creek	0- 4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	--	3	5	--	--	272	--	2	4	--	2	3	6	4
	≥ 12.0	--	3	5	--	406	970	--	14	26	--	8	14	36	21
	Total	--	6	10	--	406	1242	--	4	6	--	3	5	10	7
Hyalite 1	0- 4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	5	6	1	126	307	41	2	3	1	2	2	1	5	5
	≥ 12.0	1	3	2	104	419	335	3	8	6	2	6	5	15	13
	Total	6	9	3	230	726	376	2	3	1	2	3	1	7	5
Hyalite 2	0- 4.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	5-11.9	4	--	--	188	--	--	9	--	--	6	--	--	9	6
	≥ 12.0	7	3	2	1229	550	405	25	14	11	17	9	6	43	29
	Total	11	3	2	1417	550	405	15	5	4	10	3	2	23	14

SUMMARY AND DISCUSSION

More than 350 MMBF of timber has been killed on the Bozeman-Gallatin Ranger District since 1969. Total infested area, as mapped from aerial detection surveys in 1977, is 146,000 acres.

In 1976, the Gallatin Forest hazard-rated lodgepole pine stands and prepared a hazard map based on tree age, diameter, density, and elevation (McGregor et al. 1976). Infestation mapped during aerial surveys was plotted on the hazard map and showed that in 1977, 44 percent of the stands rated highly susceptible, 46 percent of the stands rated moderately susceptible, and 34 percent of those rated as low susceptibility have now been infested (table 2). From 1976 to 1977 there was an 85 percent increase in infested area in those stands rated highly susceptible, a 121 percent increase in stands rated moderately susceptible, and an 82 percent increase in stands rated low susceptibility (table 2). This indicates that when using only tree age, d.b.h., elevation, and latitude for hazard rating lodgepole pine stands, the ratings may be accepted for predicting hazard early in the infestation. Then validity may decline as infestation time progresses. Therefore, other factors such as slope, aspect, habitat type, percent lodgepole pine in the stand, and basal area should be used in hazard rating.

Infestation has declined in stands that were infested in 1969 and 1970 because the majority of preferred trees have been killed. However, sufficient high risk stands are available to sustain epidemic beetle populations for several more years.

Table 2.--Percent of stands infested from 1975 through 1977, according to hazard rating, Bozeman-Gallatin Ranger District, Gallatin National Forest, 1977

Priority rating	1975		1976		1977	
	Acres infested	Percent infested	Acres infested	Percent infested	Acres infested	Percent infested
High	3,677	6.0	14,201	23	26,332	44
Moderate	2,700	3.9	14,201	21	31,401	46
Low	1,167	2.3	9,645	19	17,536	34

Based on buildup ratios from 1975 through 1977 and on the formula $Y = y + bx$ (Baker 1968) where:

Y = The potential cumulative number of trees killed predicted through 1978

y = Cumulative number of trees killed through 1977

x = Number of trees killed in 1977

x_1 = Number of trees killed in 1976

$b = \frac{x}{x_1}$

it is predicted that over 7 million trees will be killed in 1978, bringing the cumulative kill to about 14.5 million trees through 1978. If the buildup ratio (1977:1978 killed trees) is only 1:1, over 4 million trees will be killed in 1978. However, buildup ratio is expected to exceed 1:1.

Based on the hazard rating system developed by Amman et al. (1977), stands evaluated were rated using age, elevation, and average d.b.h. By multiplying the following factors, 1 = low, 2 = moderate, and 3 = high, a susceptibility classification for the stands evaluated was obtained (table 3).

Table 3.--Hazard rating for infested lodgepole pine stands evaluated, Bozeman-Gallatin Ranger District, Gallatin National Forest, 1977

Area	Avg. age > 5 in. d.b.h.	Rating	Elevation	Rating	Avg. d.b.h. (inches)	Rating	Overall index	Hazard
Spanish Creek 1	145	3	6600-8200	3	9.3	3	27	High
Spanish Creek 2	145	3	6600-8200	3	8.6	3	27	High
Squaw Creek	139	3	5400-8600	3	6.6	1	9	Low
Swan Creek	133	3	5600-8600	3	8.8	3	27	High
Portal Creek	139	3	5700-8400	3	6.6	1	9	Low
Porcupine	139	3	5900-8400	3	10.5	3	27	High
Bear Creek	139	3	5600-8400	3	9.3	3	27	High
Hyalite 1	139	3	5500-8400	3	8.4	3	27	High
Hyalite 2	139	3	5500-8400	3	10.2	3	27	High

Tree mortality is expected to continue at epidemic level in stands rated high hazard, and infestation will develop in many uninfested stands rated as moderately hazardous.

RECOMMENDATIONS FOR MANAGEMENT

Potential losses from the mountain pine beetle can be reduced through an accelerated program of (1) sanitation salvage cutting (Safranyik et al. 1974; Cole 1977) and (2) silvicultural management.

Where stand composition of lodgepole pine is pure and form is even-aged, management may be limited to: (1) salvage cutting, (2) organized clearcutting in blocks to create age, size, and species mosaics from mature stands, and (3) stocking control in young stands (Cole 1977).

Sanitation salvage is aimed at reducing beetle populations by removing and processing infested trees. It should be directed to infested stands where it is too late for preventative management. An accelerated salvage effort in these stands may protect not only adjacent high-volume stands, but other resource values.

Infested stands and stands rated high hazard that could sustain extensive mortality for several years can be managed in several ways, depending upon land-use objectives and whether stands are pure even-aged, or pure uneven-aged, and mixed species (Amman et al. 1977; Cole 1977).

Organized block cutting to create age and size mosaics from extensive, pure, even-aged stands is a highly recommended practice (Roe and Amman 1970; Amman 1976). Since significant acreages are infested, commercial forest land should be identified for: (1) currently vulnerable--but as yet uninfested stands, as well as (2) those that will attain the tree size and phloem thickness preferred by the beetle within about 15 years (Cole 1977). In identifying these stands, differences in stand preference by the beetle according to habitat type, age, soil, elevation, slope, aspects, stand density, and species composition should be considered.

In considering a schedule of block cutting on sites where probability of loss is high, additional losses may be prevented by directing regeneration of sites to patterns of alternating species among blocks or to an overall pattern of mixed species within blocks, suited to specific habitat types (Cole 1977).

Stocking control is an important preventative practice in pure, even-aged lodgepole pine because it allows the reduction of stand growth toward moderate tree size and rotation objectives that are not greatly threatened by mountain pine beetle. Stocking control by age 25 to a spacing of about 10 by 10 ft. results in culmination of mean annual cubic volume increment on medium to good sites at about age 80 years, with average stand diameters of about 10 inches d.b.h. (Cole 1973). Projected diameter distributions for this kind of stand indicate largest diameter classes (14 in. d.b.h.) represent less than 1 percent of the stand; while trees over 12 inches d.b.h. comprise about 8 to 10 percent of the stand. These rotation and size

limits do not appear to be very susceptible to mountain pine beetle epidemics (Safranyik et al. 1974; Cole and Cahill 1976), except at low elevations on extremely good sites (Amman et al. 1977).

In mature uneven-aged or mixed species stands with large lodgepole pine in the overstory, cutting units could be treated by block clearcutting as a preventive, and if the stand or block is infested, losses could be reduced by salvage-cutting. In mixed stands, species discrimination and stocking control are possible while reducing stand density (Cole 1977).

Selecting against lodgepole pine in older mixed stands through partial cuts in which only the preferred lodgepole pine portion is removed is recommended (Cole 1977).

Partial cutting of larger diameter trees is recommended and can reduce infestation potential in susceptible stands (Cole and Cahill 1976; Hamel and McGregor 1976; Hamel 1977). However, susceptible stands that are predominately lodgepole pine should be carefully selected for partial cutting to maintain adequate productivity, unless the residual stand is younger than 50 years. In younger-age stands, it may be better to completely remove the overstory than to partial cut thus removing only larger diameter preferred trees, for future growth of the understory (Cole 1977).

Partial cutting, or "green sanitation salvage", is encouraged in stands that are being attacked, or soon will be. The larger lodgepole pine can be removed prior to attack (along with those already infested), thus reducing productivity of the residual stand and accept it as the condition the beetle would leave it anyway. Utilization of sound trees and direct control of mountain pine beetle population is therefore made possible by denying the beetle favorable host trees for a population buildup. This can buy time for accomplishing preferred block cutting otherwise precluded by lack of time (Cole 1977).

Two factors must be carefully considered when planning and executing green sanitation salvage to avoid reducing long-term timber productivity more than the mountain pine beetle would:

1. Only trees preferred by the beetles should be removed. Guidelines for estimating this are provided (Cole and Cahill 1976; Amman et al. 1977).

2. Seed should be collected from the most vigorous large trees, and regenerated on the site by planting at the appropriate time. This is because the faster growing genotypes appear to be selected over the slower growers for removal by mountain pine beetle--consequently, also by green sanitation salvage (Cole 1977).

Reducing Losses In Noncommercial Units

One viable management alternative is to do nothing. Losses are usually determined in terms of impairment of visual resource and increased costs to maintain convenience and safety for users.

Trees in picnic areas, campgrounds, around visitor centers, and summer and permanent homesites have a much higher value than trees in a forest situation.

Preventing snags in high-use areas and administrative sites will reduce the shedding of needles, dead branches, or portions of the tip or trunk of snags weakened by decay (Wagner 1963).

Preventive sprays (Sevimol-4®) are available for protecting high value trees (Gibson 1978); and must be applied before beetle flight. Hazard trees should be removed. Protecting high value trees until the infestation subsides will prevent the need to rehabilitate campgrounds by planting, and will protect esthetic values.

A conscious silvicultural program of fire management and prescribed burning could be instituted in some areas. Stands should be accurately mapped for stand age, size structures, and fuels. Once these data are obtained, fires could be let burn under "supervision" to create a mosaic of regenerated stands within extensive areas of large timber. To more quickly return these ecosystems to their natural balance with fire, prescribed fire can be used. Prescribed burning is advantageous over trying to manage naturally occurring fires in high-hazard situations such as in mountain pine beetle infested areas, particularly in areas where dead fuels accumulate to the point that large hot fires could occur. These fires are more destructive than those that would have naturally occurred and they also intensify and perpetuate extremes in the mountain pine beetle fire situation (Cole 1977).

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